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FACILITY FORM 602

<b>N66-20132</b>	
(ACCESSION NUMBER)	(THRU)
<b>9</b>	<b>1</b>
(PAGES)	(CODE)
<b>CR 70926</b>	<b>05</b>
(NASA GR OR TMX OR AD NUMBER)	(CATEGORY)

GPO PRICE \$

CFSTI PRICE(S) \$

Hard copy (HC) 1.00

Microfiche (MF) 50

# 653 July 65

Semiannual Report, Contract Nonr-47-01-001  
1 June 1965 through 31 November 1965  
Supported by Fund Transfer F-129 from  
Office of Grants and Research, National  
National Aeronautics and Space Administration  
and

Sixth quarterly status report,  
NASA Number F-129-09-01-001  
1 September 1965 through 31 November 1965

11 February 1966

Page No. 17

Prepared by L. A. Jeffress and C. S. Watson



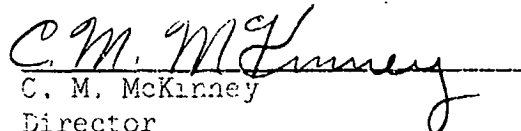
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11 February 1966  
LAJ:ph

Semiannual Report for Contract Nonr-3579(04)  
for the period of 1 June 1965 through 30 November 1965  
Supported by Fund Transfer R-129 from Office of Grants and Research Contracts,  
National Aeronautics and Space Administration  
and  
Sixth Quarterly Status Report for NASA Number R-129-09-030-017  
for the period 1 September 1965 through 30 November 1965

by

Lloyd A. Jeffress and Charles S. Watson

I. STATUS OF PROPOSED PROBLEM

A. Vigilance Studies  
(C. S. Watson and T. L. Nichols)

The construction of a new laboratory facility for the study of auditory detection and its autonomic concomitants has been completed and has been in operation for some weeks. The new facility is equipped with a six-channel physiological recorder and response latency measuring apparatus.

A new psychophysical method was developed to permit the analysis of vigilance performance in terms of the theory of signal detectability. In this method, the observer is deprived of all cues about the occurrence of a trial; an obvious advantage in the study of vigilance performance, since the customary trial warning light and its unknown effect in alerting the observer to the occurrence of weak, infrequent signals is eliminated.

A study validating this new method has been completed, and it has been determined that the index of detectability ( $d'$ ) computed by the new method is comparable to the  $d'$ 's obtained under conventional TSD paradigms.

A second study, employing the new method, was conducted to investigate the contributions of observer sensitivity and response criterion in the classical vigilance decrement. The analysis of this study is in progress.

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In both studies, the state of autonomic arousal (GSR) of the observers was monitored, and will be evaluated against the correctness of each response, and overtime on the vigilance task.

B. Psychophysical Studies of Brightness: Effects of Adaptation on the Brightness of Positive and Negative Flashes of Light  
(G. H. Jacobs and H. A. Gaylord)

The data collection phase of our initial experiments concerning the effects of adaptation on the brightness of flashed incremental and decremental stimuli is now completed. In that experiment (the data are currently being analyzed) estimates of brightness were obtained from 25 subjects who viewed brief (300 msec) flashes of light, varied stepwise over a range of 2 log units of luminance around an adaptation level. Each subject was run under four adaptation conditions covering a total range of 5 log units of luminance. The major interest here is in delineating the change in brightness for stimuli both above and below the adaptation luminance, and to see how this function depends on adaptation condition. Two other related experiments are planned. In the first, an attempt will be made to examine brightness in the same shift situation as outlined above, to find the size of luminance shifts necessary for estimated brightness to become asymptotic and to see if this is the same for shifts in both increment and decrement directions. In the second experiment we plan to examine in detail the structure of the brightness function for small luminance shifts and to compare the direct estimation technique with other psychophysical approaches.

C. Signal Detection and the Width of Critical Bands  
(L. A. Jeffress)

A set of low-pass and high-pass filters have recently been delivered and mounted for use. They permit generating band-pass filters with high- and low-frequency cutoffs at various locations relative to the signal frequency (500 Hz). Before using them in an experiment with human observers, they are being employed in a detection study using the Computer of Average Transients (CAT) to obtain ROC curves.

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A particularly interesting combination is under study at the present time. It resembles more closely the type of filter thought to be employed by the ear than any employed so far in model studies. It consists of two low-pass filters, one with its cutoff at 525 Hz and the other at 500 Hz. The response curve of the filter resembles rather closely the type of frequency response reported for many fibers of the auditory nervous system in having a very sharp slope on the high-frequency side and a much flatter skirt for the low frequencies.

D. Psychometric Functions for an Ear Model as a Function of Duration  
(L. A. Jeffress and A. D. Gaston)

The Theory of Signal Detectability (TSD) has not so far developed a mathematical model to account for the relative invariance of the measure of detectability,  $d'$ , with signal duration when signal energy is kept constant. Green, Birdsall, and Tanner (J. Acoust. Soc. Am. 29, 523-531, 1957) found little or no change in  $d'$  for a range of signal durations from about 10 msec to about 200 msec when signal energy was kept constant. The masking noise was continuous. TSD is based on the statistics of sampling both noise and signal-plus-noise according to the same scheme and therefore appears inappropriate for the case where the noise is continuous and only the signal is gated.

Our experiments with an electrical model employing a narrow filter followed by an envelope filter and detector and reported at the June meeting of the Acoustical Society of America showed preference for a signal duration which is the reciprocal of the bandwidth of the filter. This is what would be predicted from filter theory.

A number of unsuccessful attempts were made to change the characteristics of the detector in order to approximate the results obtained by Green, et al, and recently a new attempt was successful. It involved the use of a linear half-wave rectifier following the filter and followed in turn by an integrator with a long delay time, 200 msec. The choice of 200 msec was based on work by Zwislocki on integration in the ear. Data taken with the new model gave

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about the same uniformity of detection when signal energy was kept constant as was found by Green, Birdsall, and Tanner, and psychometric functions similar to those soon to be published by Green in the Journal of the Acoustical Society of America.

We are planning to repeat this study with the more "earlike" filter described in Section C.

As a result of the foregoing findings, Green (personal communication) is working on a modification of the energy detection model described in Chapter 13 of Signal Detection Theory and Psychophysics, Report No. 1244, April, 1965 (Final Report under Contract NASw-676 for NASA Code REC), to fit the case where the noise employed is continuous and the signal is gated.